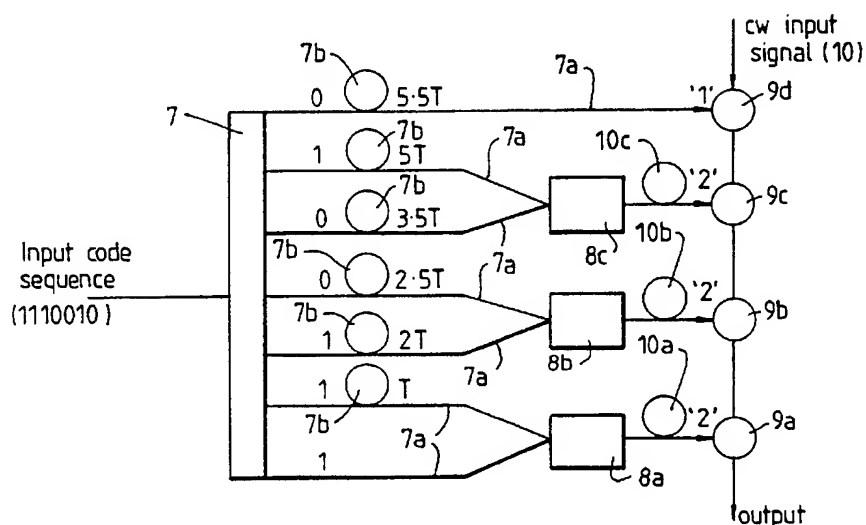# PCT

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: OPTICAL DECODING FOR MANCHESTER ENCODED SIGNALS

(57) Abstract

An optical code recognition unit (OCRU) for recognising a predetermined n-bit optical code sequence coded using the Manchester code format, has an n-way splitter (7) having an input and n parallel outputs (7a). A plurality of gates (9a, 9b, 9c, 9d) are associated with the splitter outputs (7a), respective pairs of splitter outputs leading to each of the gates (9a, 9b, 9c) via a respective optical combiner (8a, 8b, 8c), and any remaining single splitter output leading directly to its gate (9d). Each of the splitter outputs (7a) is subject to a different delay of m half bit periods, where m = 0 to 2(n-1), the values of m being chosen such that, if a predetermined optical code sequence is applied to the splitter input, the '1's in the outputs of each of the pairs of splitter outputs (7a) reach the associated AND gates (9a, 9b, 9c) and the '1' in any remaining single splitter output (7a) reaches its AND gate (9d) at predetermined times such that all the gates are turned on.

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## OPTICAL DECODING FOR MANCHESTER ENCODED SIGNALS.

This invention relates to optical processing in networks carrying packetised signals, and in particular to an all-optical code recognition unit for such a network.

5      Optical fibre communication offers many advantages over conventional wire based systems, these advantages including reduced losses, increased bandwidth, immunity from electromagnetic interference (EMI), and a high level of security.  The application of optical fibre technology into
10    the local area network (LAN) is, therefore, of increasing interest.  In the past, however, it has been assumed that optical networks will only penetrate small business and residential sectors if new broadband services are provided to offset the additional costs involved in the installation of
15    the optical technology.  Some of the broadband services that could be provided are alpha-numeric videotex (e.g. Prestel), photographic videotex, high definition television, interactive video on demand (video library), video telephony, interactive graphics and high-speed data services.

20    Although the importance of providing such services has been recognised for some time, it is difficult for telecommunications operating companies to predict their market potential and therefore justify a major investment.  What is required is an entry strategy that allows optical technology
25    to be installed economically for telephony and low-speed data services, while maintaining the potential for evolution at a marginal cost for future broadband services.

In known optical networks, routing of information is achieved at each node by electronic means, that is to say by
30    detecting the received optical signal to give an electrical signal (plus detector noise).  This electrical signal must be regenerated, after processing and switching to remove the noise, before the signal is re-transmitted optically. Regeneration is bit-rate dependent, and so restricts the
35    information type that can be carried, thereby preventing the transmission of broadband services.  The need for regeneration

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could be removed by coupling off, at each node, part of the received optical signal, the coupled-off signal being converted to an electronic signal which is electronically processed, the remaining uncoupled optical signal being re-

5 routed by the electronic processor.   Unfortunately, the electronic processing times severely limit the possible capacity of the optical links, so again the provision of broadband services is not practical.   Thus, although the electronic processor can switch quickly (of the order of

10 nanoseconds) it requires a relatively long time (of the order of microseconds) to process, and therefore to decide upon the necessary route of the signal.   In this scheme, the uncoupled optical signal is delayed during the processing time by a long length of optical fibre, and this obviously increases the size

15 of each switching node.

Optical routing of information at the nodes of such an optical network would increase the capacity of the network by reducing the processing time.   Not only would this increase the capacity of the network, it would also decrease the vast

20 delay lengths of optical fibre otherwise required.   Optical signal processing is well known, but the particular method of optical routing in a given network will depend upon the nature of that network.   A particularly advantageous type of optical network is the recently developed telephony over passive

25 optical networks (TPON).   This type of network has no routing mechanisms, that is to say all terminals receive all the information transmitted by the exchange.   One of the main advantages offered by TPON is the ability to move transmission between customers.   This is because the gross bit-rate used

30 with TPON is 20Mbit/s (chosen mainly to allow cheap CMOS realisation of signal processing chips), and this is divided into a basic granularity of 8kbit/s, that is to say 8kbit/s is the basic transmission unit that can be moved from customer to customer (or can be summed to provide channels of nx8kbit/s

35 capacity).   This ability suggests that TPON will be particularly applicable to the small business sector.   TPON also shows great promise for the economic provision of optical

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fibre to the telephony customer, with major potential for later extension to broadband integrated services digital networks (ISDN).

In order to enhance management and flexibility of the core
5  of the network of the telecommunications network, a synchronous digital hierarchy (SDH) managed transmission network is planned as a replacement for the present asynchronous trunk and junction networks. An SDH network would have four different levels, with a passive optical
10  network (PON) at the lowest (Access) level, and a high capacity routed network at the upper (Inner Core or Long Haul) level. The Inner Core level would benefit the most from optically-controlled routing, as this level requires the largest capacity. The increase in capacity required at the
15  Access level (because of the addition of extra services) would, however, benefit from the use of optical routing. At the Access level, it is envisaged that there would be sixty-four access points to each node. It would, therefore, be possible to address each individual node by a series of code
20  sequences, each code sequence allowing up to sixty-four permutations.

One method of implementing an SDH network, that achieves flexibility and supports the divergent needs of future services, is based on packet switching which is currently used
25  in data networks where error-free communication is required. The protocols required for such a system contain sophisticated methods for correcting, retransmitting or re-routing packets, and so need a lot of processing which can cause long delays. To accommodate delay-critical, but error-tolerant services,
30  such as voice, a much simpler protocol can be used to minimise the processing time required. An example of this technique, which is known as asynchronous transfer mode (ATM) is used for fast packet switching or asynchronous time division (ATD).

ATM is a label multiplexing technique that uses short,
35  fixed length packets, or cells. The ATM cells are short to reduce packetisation delay, and are of fixed length to make it easier to bound delays through switches and multiplexers.

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They have short labels (or headers) to allow cells to be routed, at high speeds, by means of hardware routing tables at each switch. For large transmission bandwidths (~1Gbit/s or more) this routing may be most effectively performed optically
5 via optical code recognition (OCR).

The packet header and information fields must be separated at nodes where OCR of the header is to take place. This could be achieved by having the information field at bit-rates far in excess of the header bit rate and the response time of the
10 optical code recognition unit (OCRU), so that the OCRU, being too slow to "see" the information field bit rate will only "see" a constant intensity after the header. Alternatively, and preferably, the header and information fields could be at different wavelengths, so that they may be split easily,
15 either by a wavelength dependent coupler or by means of wavelength division multiplexing technology.

In developing a system of optical code recognition for use in optical routing of TPON, the following requirements must be met, namely: -
20          (a)     Around 64 codes are required with the minimum of redundancy. This is due to the SDH network requiring up to 64 codes at each level of the network adequately to address each access terminal;
              (b)     The OCRU should be self timing, that is to say
25 a clock signal should not be required to synchronise the OCRU;
              (c)     The OCRU should be realised using the minimum number of components, thus keeping cost and complexity down;
              (d)     The match/mismatch decision of the OCRU must be achieved very quickly, that is to say the OCRU must have lower
30 processing times than electronic systems; and
              (e)     The logic level of the OCRU output should be kept to a minimum, since multiple level logic is easily degraded by the noise that is always present in real systems.

The specification of our International patent
35 application GB 93/00090 describes an OCRU for recognising a predetermined n-bit optical code. The OCRU comprises an n-way splitter having an input and n parallel outputs, a plurality

of combiners associated with the splitter outputs, and a respective gate controlled by the output of each of the combiners. Each of the splitter outputs is subject to a different delay of from 0 to (n-1) bit periods, and each
5    combiner receives an input from at least one of the splitter outputs. The OCRU is such that all the gates are turned on if a predetermined optical code is applied to the splitter input. Each combiner is configured to operate at 2-level logic, and the arrangement is such that, when the predetermined optical
10   code is input to the n-way splitter, each combiner receives an input of one or more '0's or one or more '1's, and each combiner receiving '1' inputs receives a maximum of two such inputs.

With this arrangement, each gate receiving one or more
15   '1's performs the 'AND' logic operation, and each gate receiving one or more '0's performs the 'INVERTER' logic operation. The disadvantage of this is that, although 'AND' logic operations can be implemented fairly easily in a number of technologies, for example by semiconductor based devices,
20   fibre based devices (such as loop mirrors) or polymer devices, 'INVERTER' logic operations are much harder to implement. Another disadvantage of this known split-and-combine technique is that two bits (the first and last) must be used for identifying the start and end of an input code sequence, so
25   the code efficiency of the technique is reduced to 25%.

The present invention provides an OCRU for recognising a predetermined n-bit optical code sequence coded using the Manchester code format, the OCRU comprising an n-way splitter having an input and n parallel outputs, and a plurality of AND
30   gates associated with the splitter outputs, respective pairs of splitter outputs leading to each of the AND gates via a respective optical combiner, and any remaining single splitter output leading directly to its AND gate, wherein each of the splitter outputs is subject to a different delay of m half bit
35   periods, where m = 0 to 2(n - 1), the values of m being chosen such that, if a predetermined optical code sequence is applied to the splitter input, the '1's in the outputs of each of the

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pairs of splitter outputs are input to the associated AND
gates and the '1' in any remaining single splitter output is
input to its AND gate at predetermined times such that all the
AND gates are turned on.

5       Advantageously, the gates are positioned in series
between an input device and an output device, whereby a signal
input by the input device will reach the output device if the
predetermined code is input to the n-way splitter.
Preferably, the input to each of the AND gates except that
10  nearest the input device is subjected to a predetermined
delay, whereby the signal input by the input device will reach
the AND gates at substantially the same time as said inputs.
Each of the AND gates may be an SLA.

        The invention also provides a system for processing
15  packetised signals in a network comprising a head-end packet
signal transmitter and an plurality of customer receivers,
the system comprising a respective apparatus associated with
each customer receiver, each apparatus comprising separator
means for separating header field information from data field
20  information in packets, first transmission means for
transmitting the header field information to a switch
associated with the respective customer receiver, and second
transmission means for transmitting the data field information
to said switch, wherein each first transmission means includes
25  an OCRU as hereinbefore defined, and wherein each apparatus is
such that the respective OCRU activates the associated switch
to permit the passage of the data field information of a given
packet only if the optical code contained in the header field
information of that packet is the predetermined optical code
30  of that OCRU.

        Conveniently, each of said switches is a bistable
switch constituted by an SLA.

        Advantageously, a respective wavelength-dependent
coupler constitutes the separator means of each apparatus.

35      Preferably, the second transmission means of each
apparatus includes an optical delay fibre of such a length
that the header field information of a given packet reaches

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the switch substantially as the switch is activated by the
OCRU.

Advantageously, the network is a packet switched
network, the head-end packet signal transmitter is a head-end
5  packet transmitter, and the packets are cells consisting of
headers and data.

An optical routing apparatus incorporating an optical
code recognition unit constructed in accordance with the
invention will now be described in greater detail, by way of
10 example, with reference to the accompanying drawings, in
which: -

Figure 1 is a schematic representation of the routing
apparatus;

Figure 2 is a schematic representation of an optical
15 code recognition unit forming part of the apparatus of Figure
1; and

Figures 3a and 3b illustrate the Manchester code format
used in the invention.

Referring to the drawings, Figure 1 is a schematic
20 representation of a customer-end optical routing apparatus for
use with a TPON system carrying packetised signals (one cell
of which is indicated by the reference numeral 1).  Each cell
1 has a data field 1a and a header field 1b, these two fields
being transmitted at different wavelengths.  The customer-end
25 routing apparatus includes a wavelength dependent coupler 2
which separates the header field information from the data
field information.  The header field information is fed to a
bistable switch 3 (and then on to the customer's receiver 4)
via an OCRU 5.  The data field information is fed to the
30 bistable switch 3 via a delay fibre 6.  The bistable switch 3
is constituted by a split-contact laser amplifier having a
maximum rise time of less than 200 psec.

The OCRU 5 is configured to a particular optical code
which is unique to the customer concerned, the optical code
35 corresponding to all or part of the header field 1b.  The OCRU
5 will, therefore, provide an output signal only when it
recognises the particular optical code appropriate to the

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customer.   This output signal is used to control the bistable
switch 3 so that the data field information is routed to the
receiver 4.   The delay fibre 6 is chosen to ensure that the
data field 1a of the same cell 1 as the header field 1b
5  recognised  by  the  OCRU  5  is  passed  to  the  receiver  4.
Consequently, signals (packets) intended for other customers
will not be routed to that particular customer's receiver 4.
         Figure 2 shows the OCRU 5, this OCRU being configured
to recognise the optical code 1110010.   The OCRU 5 includes a
10  passive  seven-way  optical  splitter  7  having  seven  parallel
output fibres 7a,  three optical combiners 8a,  8b and 8c and
four SLA gates 9a,  9b, 9c and 9d.   Each of the fibres 7a is
given a different delay so that the splitter 7 converts the
serial input code into a parallel output code, with one bit of
15  the code on each of the output lines 7a.
         The OCRU 5 is configured to work with incoming code
sequences coded using the Manchester code format.   In this
format (see Figures 3a and 3b),  '1's and '0's are represented
as 01 and 10 respectively in the input header code sequences,
20  though it will be appreciated that the  '1's and  '0's could
alternatively be represented by 10 and 01 respectively.   In
the optical domain,  the transmitted levels of the header code
sequences correspond to light 'on' or 'off' to represent the
values of '1' and '0' respectively.   The important point to
25  note is that each bit period T has a signal of duration T/2
either in the first half (representing a '0') or the second
half (representing a '1') of the bit period.   It should also
be noted that the Manchester code format does not double the
number of bits in the input code sequence,  but doubles the
30  modulation bandwidth.
         The architecture of the OCRU 5 (see Figure 2) is such
that  the  incoming  code  sequence  1110010  is  split  and
differentially delayed.   This is achieved by incorporating
lengths of delay fibre 7b in each of the output lines 7a
35  except that associated with the last bit of the input header
(that is to say the most significant bit).   The length of each
of the delay fibres 7b is pre-selected so that the outputs on

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the output lines 7a reach the gates 9a to 9d at the same time.
Because the input code is in the Manchester code format, this
requires the delays on the lines to be 5.5T, 5T, 3.5T, 2.5T,
2T, T and zero respectively for the bits of the input code,
with the last bit of the input header having a zero delay.

   In the particular OCRU 5 shown in Figure 2, a first
pair of output lines 7a (which carry the two most significant
bits) are input into the optical combiner 8a, a second pair of
output lines 7a (which carry the next two most significant
bits) are input into the optical combiner 8b, a third pair of
output lines 7a (which carry the next two most significant
bits) are input into the optical combiner 8c, and the final
output line 7a (which carries the least significant bit) is
input directly into the gate 9d.

   Considering now the output of the OCRU 5 when it is
fully loaded, that is to say when the most significant bit of
the input header code sequence enters the splitter 7 and forms
an input to the optical combiner 8a along with the second most
significant bit from the arm with the delay T.   Because both
these input bits are '1's, and the delay on the line 7a
associated with the second most significant bit is a whole bit
period, the output of the optical combiner 8a has a value 2.
Similarly, the optical combiner 8b has two inputs of '1's from
the lines 7a with delays 2T and 2.5T, so its output also has
a value 2.   Again, the optical combiner 8c has inputs from its
associated lines 7a which are both '1's (the delays on these
arms being 3.5T and 5T), so that the output of the optical
combiner 8c also has a value 2.   The AND gates 9a, 9b and 9c,
which respectively receive the outputs of the optical
combiners 8a, 8b and 8c, are configured to switch on for a two
level input, and the AND gate 9d which receives the output of
the remaining line 7a from the splitter 7 is configured to
switch on for a one level input.   Consequently, if the OCRU 5
does receive the "correct" code 1110010, all four AND gates 9a
to 9d will be turned on, and an input signal 10 from a
continuous wave (cw) laser (not shown) will be passed to the
bistable switch 3.   In order to ensure that each of the AND

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gates 9c, 9b and 9a receives its input from the associated
optical combiner 8c, 8b and 8a simultaneously with the cw
input signal passed from the AND gate immediately upstream
thereof, a respective delay fibre 10c, 10b and 10a of
5  appropriate length is included between each pair of devices 9c
and 8c, 9b and 8b, and 9a and 8a. The switch 3 will then be
turned on, so that the information carried by the data field
1a of that cell whose header field 1b carries that code is
passed to the associated receiver 4. It will be appreciated
10 that a match of the code will be recognised almost
instantaneously with the input of the final (most significant)
bit of the code, so that the processing time of the OCRU 5 is
almost zero. As the AND gates 9a, 9b and 9c are configured to
operate at two-level logic, the entire OCRU 5 operates at two-
15 level logic. This avoidance of multiple-level logic is
advantageous, in that multiple-level logic is easily degraded
by the noise that is always present in real systems. More
importantly, however, all the gates 9a, 9b, 9c and 9d are AND
gates, and so these devices can be easily implemented in a
20 number of technologies, and in particular in semiconductor or
fibre-based technologies. Simple passive components can be
used for splitting, time delay and combining; and the split,
delay and combine parts of the OCRU 5 could easily be
fabricated in silica-on-silicon integrated technology. Also,
25 there is no need for the first and last bits to be used to
identify the start and finish of an input code sequence, so
that the code efficiency of this arrangement is ~100% where
there is a large number of unique codes.

Clearly, the particular form of OCRU required for each
30 customer will depend upon the code allocated to that customer.
In each case, however, the OCRU will operate at 2-level logic,
and the maximum number of SLA gates will be four for a 7-bit
code.

One disadvantage of the OCRU described above is that
35 the bistable switch 3 outputs only the data field 1a of the
recognised cell. An additional device such as an optical
transmitter must, therefore, be provided to re-input the

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header field 1b for each cell not recognised.  To remove the
need for this additional device, the OCRU may be modified by
replacing the coupler 2 with a 90/10 splitter, in which case
90% of the signal is directed towards the bistable switch 3,
5    and 10% towards the OCRU.  In this case, the header field 1b
is distinguished from the data field 1a in the OCRU by its
modulation speed (the modulation speed of the data field being
too fast for the response time of the gates).  When a header
field 1b is recognised by the OCRU, the bistable switch 3 is
10   triggered to pass the 90% part of the signal, so that header
information is passed along with the data.

In another modified arrangement, the data and header
fields 1a and 1b are on different wavelengths, and the coupler
2 is a 90/10 coupler.  A filter is positioned between the
15   coupler 2 and the OCRU 5 to prevent data signals reaching the
OCRU.  Here again, this arrangement does not require an
additional laser to re-input the header field 1b.  Moreover,
the data and header fields 1a and 1b need not be at different
speeds/bit rates.

20   In a further alternative, a time-dependent switch can
be used to separate the header field 1b from the data field
1a.  This switch would be triggered by a clock signal
extracted from the main input signal.

The routing apparatus of the invention could handle any
25   form of packetised signal, where the packets (or cells) are
divided into header byte(s) and data byte(s), such as the ATM
format.  Although at the current agreed maximum rate of 140
Mbit/s optical routing is unlikely to be beneficial, standard
agreement at higher rates could change this situation.

30   It will be apparent that modifications could be made to
the routing apparatus described above.  For example, the
bistable switch 3 could be replaced by any type of 2x2 switch,
either optically or electronically controlled.  If the switch
is electronically controlled, it will need to be provided with
35   an opto-electronic connector.  It would also be possible to
replace the SLA AND gates technology by AND gates in other
technologies such as fibre-based devices.

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CLAIMS

1.      An OCRU for recognising a predetermined n-bit optical
code sequence coded using the Manchester code format, the OCRU
comprising an n-way splitter having an input and n parallel
outputs, and a plurality of AND gates associated with the
splitter outputs, respective pairs of splitter outputs leading
to each of the AND gates via a respective optical combiner,
and any remaining single splitter output leading directly to
its AND gate, wherein each of the splitter outputs is subject
to a different delay of m half bit periods, where m = 0 to 2(n
- 1), the values of m being chosen such that, if a
predetermined optical code sequence is applied to the splitter
input, the '1's in the outputs of each of the pairs of
splitter outputs are input to the associated AND gates and the
'1' in any remaining single splitter output is input to its
AND gate at predetermined times such that all the AND gates
are turned on.

2.      An OCRU as claimed in claim 1, wherein the AND gates
are positioned in series between an input device and an output
device, whereby a signal input by the input device will reach
the output device if the predetermined code is input to the n-
way splitter.

3.      An OCRU as claimed in claim 2, wherein the input to
each of the AND gates except that nearest the input device is
subjected to a predetermined delay, whereby the signal input
by the input device will reach the AND gates at substantially
the same time as said inputs.

4.      An OCRU as claimed in any one of claims 1 to 3, wherein
each of the AND gates is constituted by an SLA.

5.      An OCRU substantially as hereinbefore described with
reference to, and illustrated by, the accompanying drawings.

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6.    A system for processing packetised signals in a network
comprising  a  head-end  packet  signal  transmitter  and  an
plurality  of  customer  receivers,    the  system  comprising  a
respective apparatus associated with each customer receiver,
each  apparatus  comprising  separator  means  for  separating
header  field  information  from  data  field  information  in
packets,  first  transmission  means  for  transmitting  the  header
field information to a switch associated with the respective
customer   receiver,   and   second   transmission   means   for
transmitting  the  data  field  information  to  said  switch,
wherein  each  first  transmission  means  includes  an  OCRU  as
claimed  in  any  one  of  claims  1  to  5,  and  wherein  each
apparatus  is  such  that  the  respective  OCRU  activates  the
associated  switch  to  permit  the  passage  of  the  data  field
information  of  a  given  packet  only  if  the  optical  code
contained  in  the  header  field  information  of  that  packet  is
the  predetermined  optical  code  of  that  OCRU.

7.    A  system  as  claimed  in  claim  6,  wherein  each  of  said
switches  is  a  bistable  switch.

8.    A  system  as  claimed  in  claim  7,  wherein  each  of  the
bistable  switches  is  constituted  by  an  SLA.

9.    A  system  as  claimed  in  any  one  of  claims  6  to  8,
wherein  a  respective  wavelength-dependent  coupler  constitutes
the  separator  means  of  each  apparatus.

10.    A  system  as  claimed  in  any  one  of  claims  6  to  9,
wherein  the  second  transmission  means  of  each  apparatus
includes  an  optical  delay  fibre  of  such  a  length  that  the
header  field  information  of  a  given  packet  reaches  the  switch
substantially  as  the  switch  is  activated  by  the  OCRU.

11.    A  system  as  claimed  in  any  one  of  claims  6  to  10,
wherein  the  network  is  a  packet  switched  network,  the  head-end
packet  signal  transmitter  is  a  head-end  packet  transmitter,

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and the packets are cells consisting of headers and data.

12.    A   processing   system   substantially   as   hereinbefore
described   with   reference   to,   and   as   illustrated   by,   the
accompanying drawings.
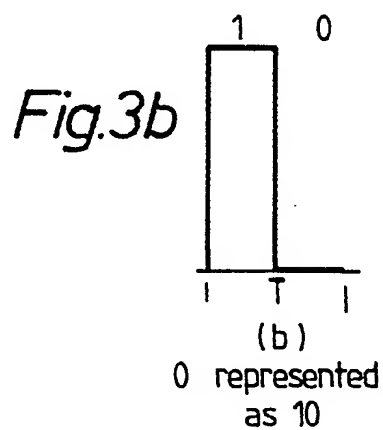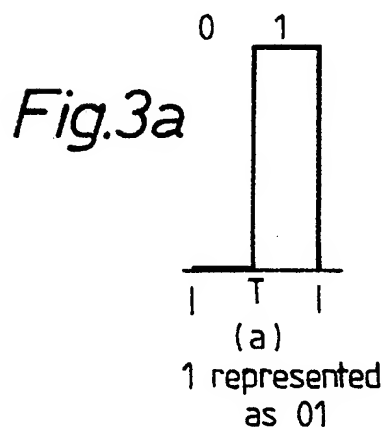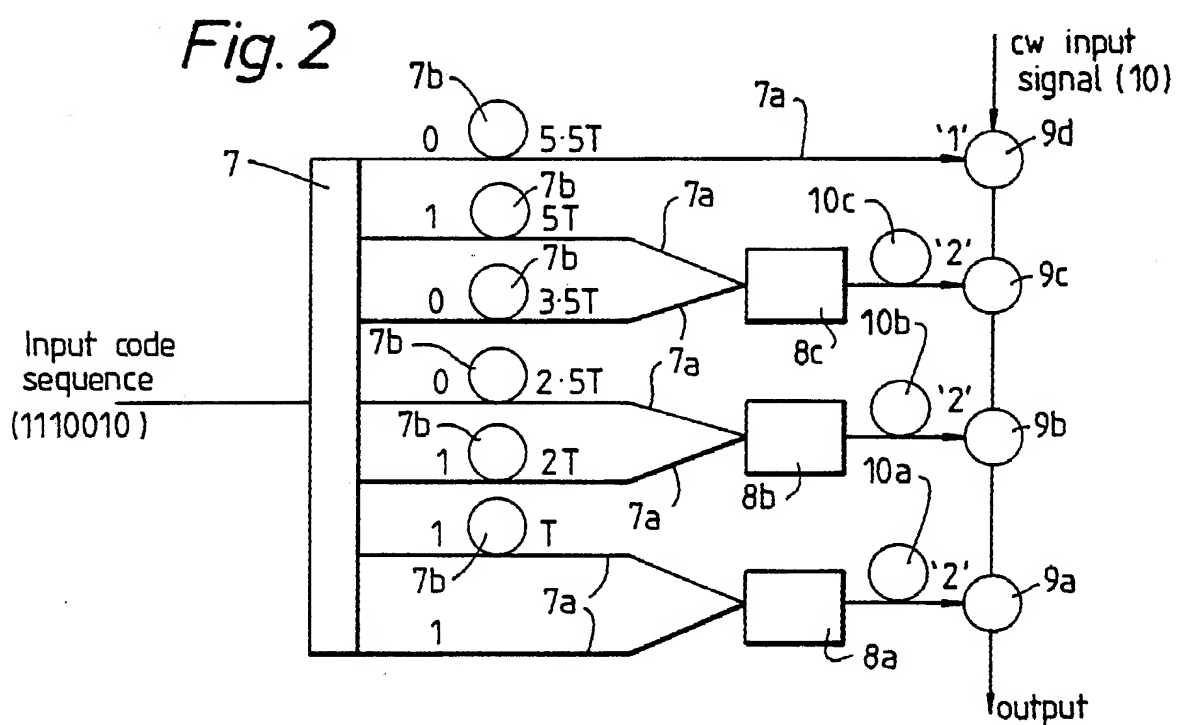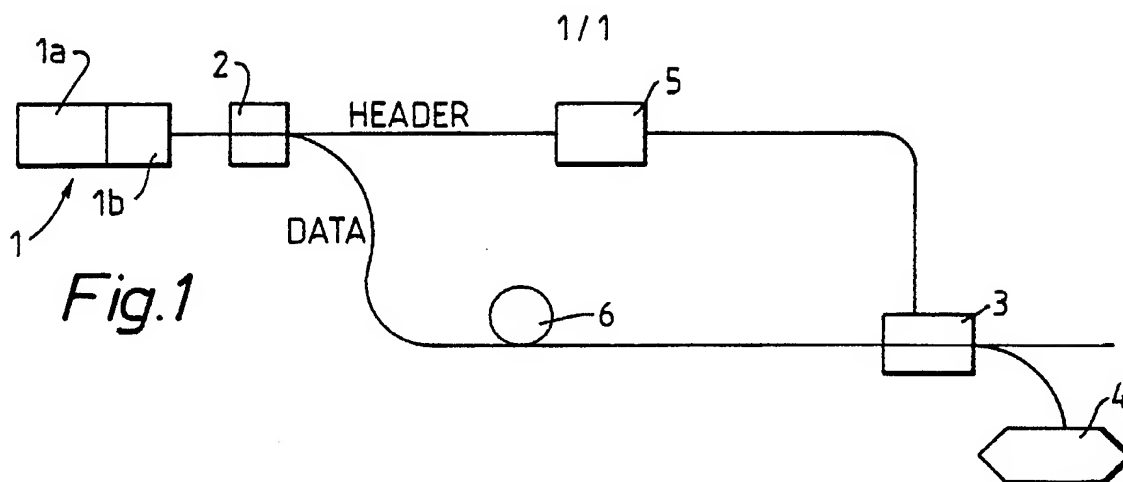
1 / 1



*Fig.1*



*Fig. 2*



*Fig.3a*

1 represented
as 01

*Fig.3b*

0 represented
as 10

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 6    H04Q11/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched  (classification system followed by classification symbols)

IPC 6    H04Q   G06E   H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | WO,A,93 14604 (BRITISH TELECOMMUNICATIONS PLC) 22 July 1993 cited in the application see the whole document --- | 1-4,6-11 |
| Y | ELECTRONIC DESIGN, vol.26, no.22, 25 October 1978, HASBROUCK HEIGHTS, NEW JERSEY US pages 84 - 91 D.J. MORRIS 'Code your fiber-optic data for speed, without losing circuit simplicity' see the whole document --- | 1-4,6-11 |
| A | WO,A,91 18485 (ASCOM TECH AG) 28 November 1991 see the whole document --- -/-- | 1-4,6-11 |

[X] Further documents are listed in the continuation of box C.          [X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 13 October 1994 | 26.10.94 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016 | O'Reilly, D |

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| C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT | | |
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| Category° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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